Automatic Identification of Solar X-ray Bright Points in Hinode X-ray Data

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Abstract

We have automated a method that is used to find point sources in *Chandra* X-ray telescope data, to identify solar bright points in *Hinode* X-ray data. This tool, called *lextrct*, first identifies candidate sources that are brighter than the surrounding background. The algorithm also allows selected pixels to be excluded from the source-finding, thus allowing saturated pixels (from flares and/or active regions) to be ignored. We then use *lextrct* to fit the sources to two-dimensional, elliptical Gaussians. The size and orientation give an approximaton of the shape of the bright points. We are in the process of analyzing observations through the Al_poly filter with a four-second exposure time, to obtain a catalogue of bright points, which will include their sizes, lifetimes, intensities, and position on the solar disk.

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position on the solar disk.

Analysis

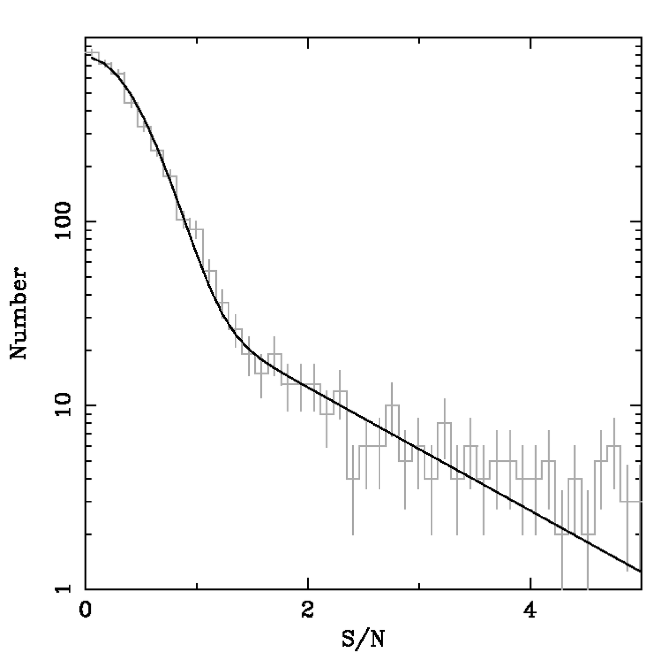
We exclude data that are greater than 95% of a solar radius from sun center. In addition, we exclude from analysis, data on the disk that are saturated. The analysis package used in astrophysics data analysis is called lextract, the Low Energy (X-ray) Telescope Data Analysis Package and may be found here:
LEXTRCT: http://wwwastro.msfc.nasa.gov/qdp/lextrct/lextrct.html

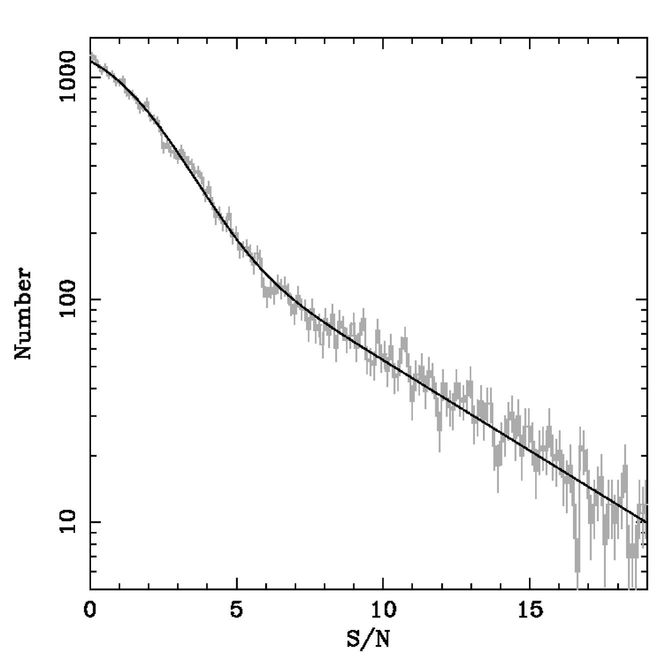
Source-Finding Component: Computes Fixed-Size, Best-Fit Gaussian to Every Pixel
Background is Locally Constant
S/N = Number of counts in Gaussian/Uncertainty
A Source = Local Maximum with S/N Above Threshold
Scale Size = Approximate Size of Bright Points

Yohkoh = 5 arcsec
Hinode = 7 arcsec

Errors and Signal to Noise

We use the lextrct default, square root of DN. Background subtraction yields negative values in the data, these are flagged and not considered in the analysis. To determine signal-to-noise threshold, we construct a histogram of the data in a region of quiet Sun. The break between components (Gaussian and power-law) gives a lower bound on the threshold. Examples are shown below.

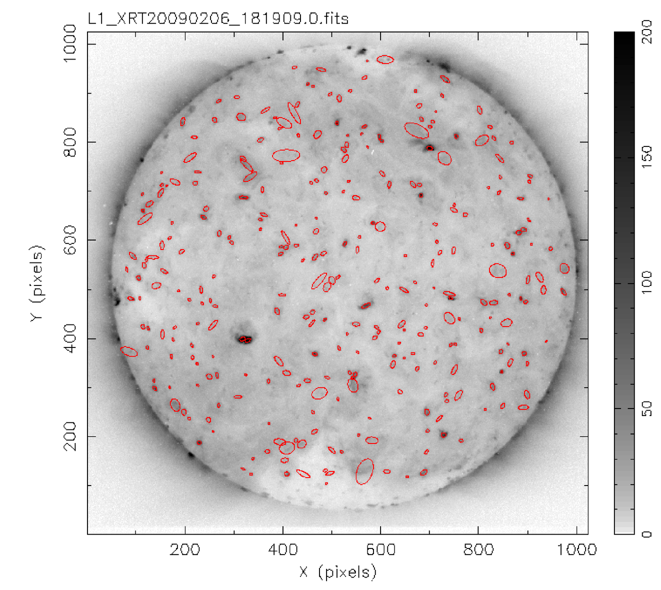


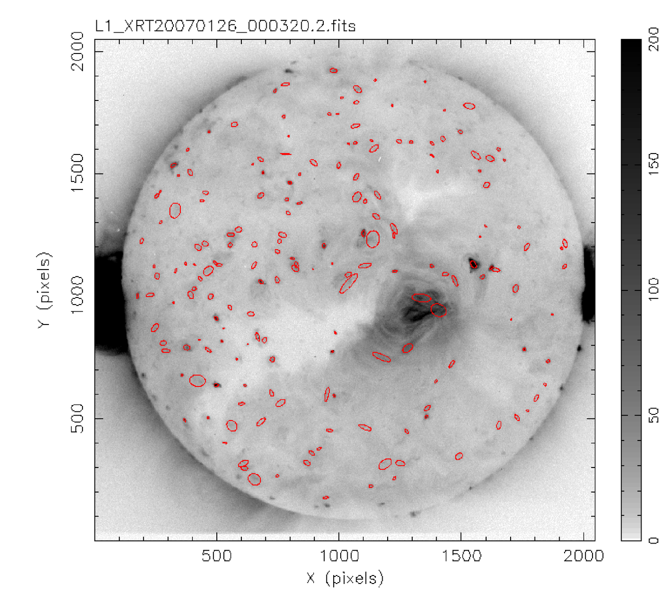


Left: A histogram of the S/N for a region of the quiet Sun using Yohkoh data from 1996-Oct-10.
Right: A histogram of the S/N for a region of the quiet Sun using Hinode data from 2006-Oct-24.

Results of Applying the *lextrct* Source-Finding Algorithm to Solar X-Ray Data

Hinode, 24 Oct 2006

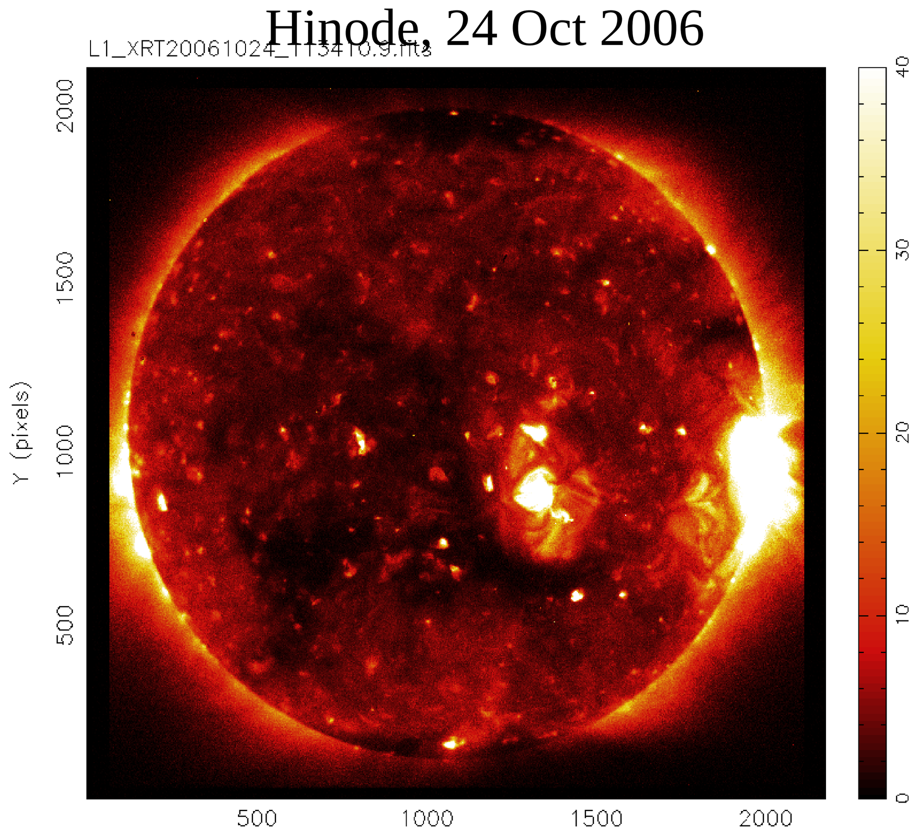




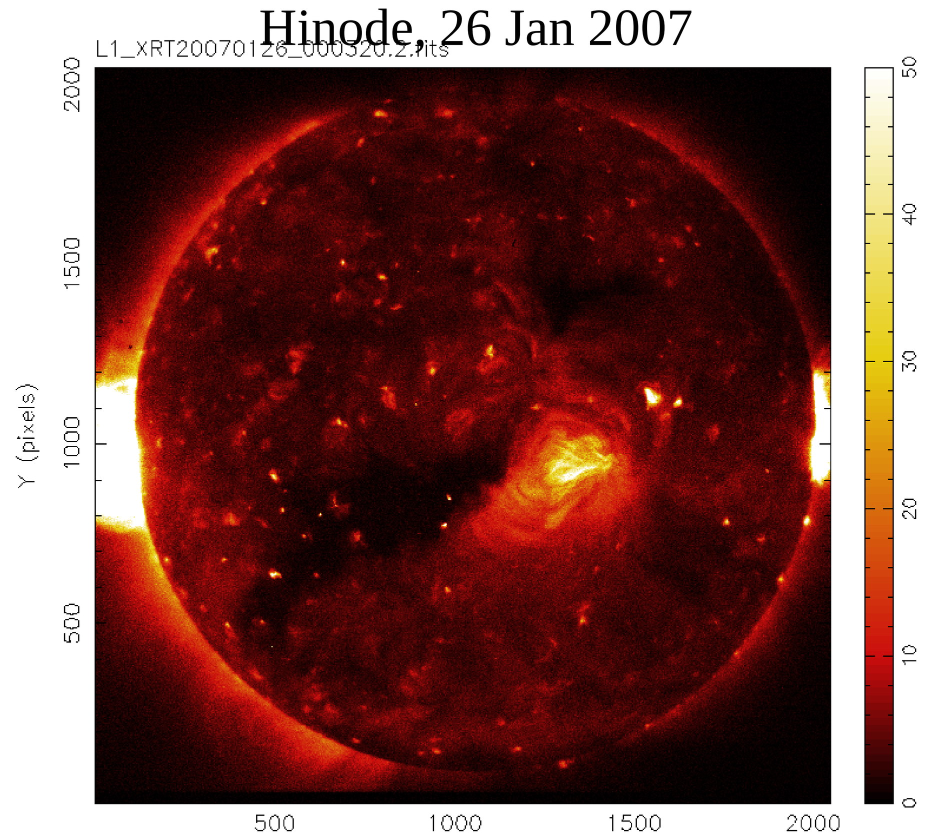
Hinode, 26 Jan 2007

DATE and TIME	Number Bright Points	Total Area BPs (Pixels)	Num Pixels Searched	Array Size (Pixels)	Exposure (sec)
2006					
10/24 11:34	211		596,599	2176 x 2112	4.10
11/02 13:47	175		555,520	2176 x 2112	4.10
11/02 15:09	177		555,330	2176 x 2112	4.10
11/02 23:00	184		556,078	2176 x 2112	4.10
11/02 23:41	172		556,649	2176 x 2112	4.10
11/09 07:01	186		570,997	2048 x 2048	4.10
11/16 19:01	154		557,915	2048 x 2048	4.10
2007					
01/05 21:41	155		564,000	2048 x 2048	4.10
01/11 03:48	179		571,949	2048 x 2048	4.10
01/11 10:05	177		572,122	2048 x 2048	4.10
01/11 15:46	175		571,720	2048 x 2048	4.10
01/11 22:01	188	91,000	573,228	2048 x 2048	4.10
01/18 06:01	149	101,000	565,187	2048 x 2048	4.10
01/25 12:01	154	83,000	573232	2048 x 2048	4.10
01/25 12:02	156	86,000	573227	2048 x 2048	4.10
01/26 00:03					
01/26 00:04					
01/27 00:01					
01/27 00:02					
06/08 05:59					
06/13 11:59					
2008					
07/28 18:01					
07/29 18:21					
07/30 18:02					
2009					
02:06 18:19				1024x1024	5.8
02:07 14:35					
02/07 18:02					
02/08 17:57					
02/09 17:45					
02/10 18:03					
02/11 19:02					
02/12 19:06					
02/13 19:25					

Hinode, 24 Oct 2006



Hinode, 26 Jan 2007



Discussion and Conclusions

Using an algorithm designed for finding astrophysical sources in data from the Chandra X-ray observatory, we examined 33 sets of solar data to find bright points. Our results are consistent with those reported in the literature.
We
will then catalogue bright points found in Hinode data with at least the following parameters: position, size, orientation.

References and Acknowledgements

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